Earthen Domes in Northern Syria. Ar-Raqqah, Aleppo, Idlib

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The area of earthen dome houses is extended from Ar-Raqqah city, belonging to 'Al-Jazira and Euphrates Region' (from the east), passing through Aleppo region to Idlib city (in the west), known as 'Aleppo Hadaba (hill) Region', covers two of eight geographical regions of Syria, which is divided into fourteen Administrative Regions.[1]

Before analyzing the mud architecture distribution in Syria, it is necessary to outline briefly about the relation between rainfall and number of existent human settlements or villages in each geographic region: for this reason we organized a table that demonstrates these important data and information which illustrate the relation between them under the effect of geographic division, and to imagine the probable effect of this relation on the distribution of earthen architecture in whole Syria.

Geographical Region	Rainfall mm/year			Area Km²	Population Habx1000	Population Density Hab/Km²	Number of Settlements
	Min.	Max.	Aver.				
1 Al-Jazira and Euphrates	135	521	275	51,000	1,806	35	2,175
2 Aleppo Hadaba	190	500	336	20,000	2,454	122	1,400
3 Al Hass River Basin	208	1,221	517	16,310	1,907	119	1,310
4 The Coast and coastal mountains	1,078	1,530	1,270	6,700	1,911	318	1,315
5 The Syrian Centre	129	150	140	20,100	45	2	100
6 The Syrian Desert	58	104	81	58,100	50	0.8	20
7 The High Mountains	136	1,133	633	5,129	386	77	53
8 The Western South Region	116	483	256	12,650	3,399	283	589
Total				189,989	11,958	63	7,002

Tab. 1: Main data concerning the geographical regions of Syria.

In table 1 we may see the data of the minimum, maximum and average rainfall of the geographical Syrian regions related to area, absolute number of people, people density and number of settlements.[2] Through these data we can observe that the minimum density of Population distribution is found in Syrian desert region, the maximum one is noticed in Syrian coast and coastal mountains, and also that Al-Jazira Region has the higher number of human settlements and villages (2,175 ones) while the desert region has only 20 aggregations according to the geographic information of 1990.

From the other hand we can mark the relation between the rainfall and the number of aggregations through the following diagram, and notice that this relation is defined by many factors: the different rainfall registrations of various stations spread on the area of each region, the proper region climate and its geological and morphological characters.

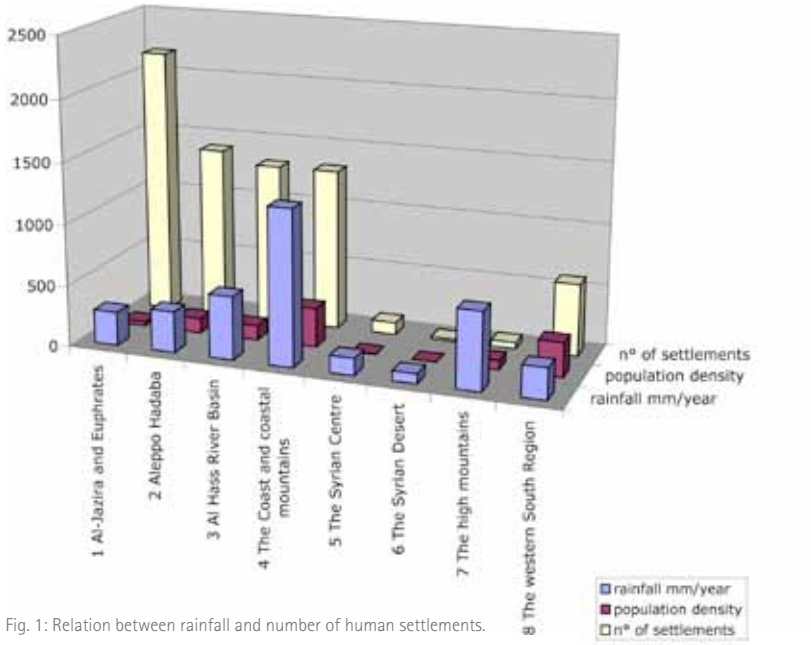


Fig. 1: Relation between rainfall and number of human settlements.

[1] The Geographic Regions in Syria are: Al-Jazira and Euphrates, Aleppo Hadaba and Ashamia Ashamalia, Al Hass River Basin, the Coast and coastal mountains, the Syrian Centre, the Syrian Desert, the high mountains, the Western South Region. While each administrative division is known as 'Muhafazah', the administrative divisions 'Muhafazat' are fourteen: Al-Hasakah, Aleppo, Ar-Raqqah, As-Suwayda, Damascus, Daraa, Deir ez-Zor, Hama, Hims, Idlib, Latakia, Quneitra, Rif Dimashq, Tartus.

[2] The data are from: Abd Assalam 1990.

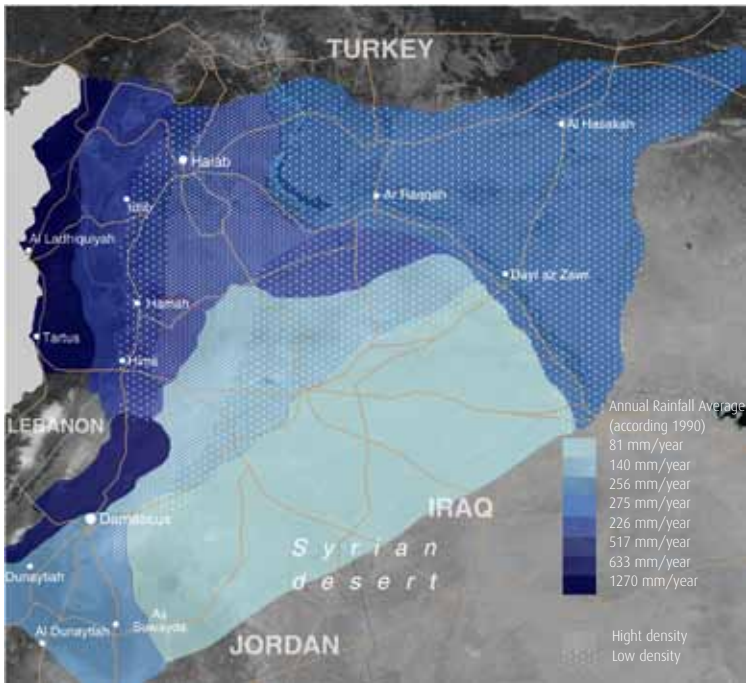


Fig. 2: Map showing the distribution of mud architecture and the geographic division of Syria with their annual rainfall average according to 1990.

On this basis we can reflect on the distribution of earthen architecture in Syria: the earthen architecture is distributed basically in three large regions: Al-Jazira and Euphrates, Aleppo Hadaba and the Syrian Centre, besides to the eastern part of Al-Hass Basin and the northern part of the Western South region.[3] We can justify this distribution and localization of earthen architecture by the following reasons:

- The Coast and coastal mountains region is generally bare from earthen houses, because it has highest annual rainfall in Syria which influence the durability of mud architecture from one part, from other part the mountains cover the biggest area of that region, and the stone can be good important alternative material from earth as a material construction
- All Al-Hass Basin region, high mountain region and Western south region do not have earthen architecture except some plains, because they are rich of stones which allow people to construct their houses.
- The Syrian desert is completely poor of earthen houses, because of its not appropriate earth for making bricks and its hot and arid climate which reduced the number of human settlements and villages.
- Usually there are dense and slight distribution of mud architecture in the regions of Aleppo, Al-Jazira and the Syrian centre; this distribution depends on the variety of local earths in each zone and its validity for construction, on the number of human settlements and the density of population and depends on the number of masonry experts in each zone.

[3] The map is elaborated from many resources, mainly from Abd Assalam 1990 and Ali n.d.

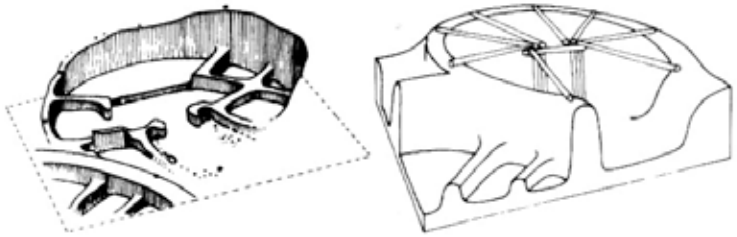


Fig. 3: First use of inclined roofs in Mureybet site (Cauvin 1984).

Elements of earthen dome architecture history in Syria.

If we want to understand the architectural culture of earthen domes of northern Syria, we need to look at them in the frame of the history of Syrian earthen architecture: the today dome architectures have very deep and far roots[4]:

- In the 9th millennium BC, Aswad site (near Damascus) knew a circular houses dug in earth, covered probably with cane treated by mud.
- The early architecture started in Al-Jazira and Euphrates region at the middle of the 8th millennium BC, as houses dug partly in earth or rock (Abu Huraira site), while Mureybet site has in the same period circular houses dug in earth, built from mud. Both of these houses perhaps were roofed with a light trunks treated with mud (Fig. 3).[5]
- The beginning of using the dome, can be probably identified in the inclined roofs of circular houses in Mureybet site (8th millennium BC) which were the first step to joint the dome, because the roofs were generally flat from the 9th millennium to 5th millennium and made from cane treated with mud, brushes and poplar, as in the following sites: Um Al-Dabbaghiyah (9000 BC), Abu Huraira (8000 BC), Buqros (6800 BC), Tell Hasan and Tell Aswad (6500 BC).

[4] See the contribution of Önhan Tunca & Katrien Rutten, The corbelled dome in the archaeology of the ancient Near East.
[5] Cauvin 1984, p.53.

Fig. 4: Spontaneous urban spaces in Aleppo (Blas).
Fig. 5: Shaped and limited urban spaces in Aleppo (Abed).

- The early dome was, probably, built in Halaf Civilization (5000 BC) and in Arpachiyah site (5000-4000 BC).[6]
- The attempts to use earthen domes did not stop in Mari architecture and Al-Salankahiyah site in the third millennium BC besides to arches and vaults in Tell Arramah and to use flat roofs in Tell Brak in the same period.
- In the second millennium BC the roofs in Tell Bderi, Tell Al-Khwaera and Ashaikh Hamad site were flat, while they were inclined (in two directions) in Mozan site.

Urban morphology of earthen dome villages

Among the earthen dome architecture villages of north of Syria which have been examined we may identify two main urban morphology types:

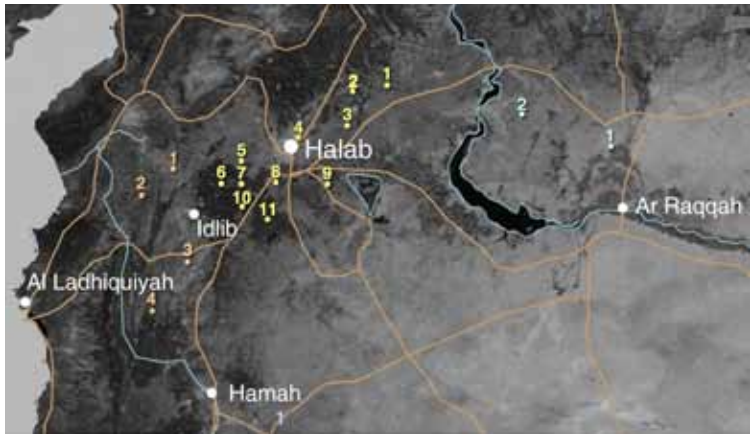
1 spontaneous villages, where the houses are spread spontaneously, there are not shaped streets, squares or precise limited urban spaces, (Fig. 4)
2 semi-regular villages, which have a general public space, semi-private spaces, main streets and more narrow streets, *Zuqaq*, besides to mosque,
3 Regular villages, which have a principal square, small squares (semi-private space), perimeter roads, interior main streets and more narrow streets, *Zuqaq*, besides to mosque and open market, *Bazar* (Fig. 5).

A first classification of Syrian dome houses

In order to outline the earthen architectural culture we examined about twenty examples distributed in three regions, Al-Jazira, Aleppo Hadaba and Al-Hass basin, as followings:

1 Al-Jazira region (Ar-Raqqah Muhafazah): Al-Baeda and Laqta village.
2 Aleppo Hadaba region:
  a. (Aleppo Muhafazah): Al-Aremeh, Al-Bab, Bza'a, Soran, Tyara, Khan Toman, Al-Wdehi, Abteen, Al-Safirah, Blas and Hamedeeh.
  b. (Idlib Muhafazah): Kelli, Ezmareen, Al-Mastumeh Ma'arrat an Numan and Kafranbel.
3 Al-Hass basin region (Hama Muhafazahh): Salamiyah.

[6] Mellart 1990.

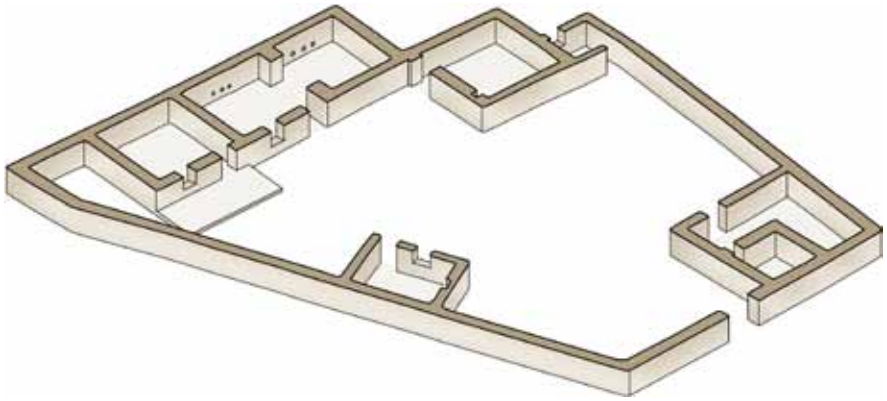


Muhafazat of Aleppo: 1 Al Aremeh, 2 Bza'a, 3 Soran, 4 Tyara, 5 Khan Al Asal, 6 Khan Toman, 7 Al Wdehi, 8 Abteen, 9 Al-Safirah, 10 Blas, 11 Hamedeeh
Muhafazat of Ar-Raqqah: 1 Al-Baeda, 2 Laqta
Muhafazat of Idlib: 1 Kelli, 2 Ezmareen, 3 Al-Mastumeh, 4 Kafranbel
Muhafazat of Hama: 1 Salamiyah

Fig. 6: Localization of the selected villages.

The elements of a basic earthen house may be the followings: one or more rooms with various functions (living, sleeping or for visitors), kitchen, bath, store, stable, toilet, fences, garden, small store for hens and pigeons, earthen traditional bakery *Tannur*, stage *Mastaba*, and well (Fig. 7).
On the basis of plans and shapes of mud houses we may identify several types of houses affected by social, economic, religious and traditional factors. We may distinguish between two principal typologies according the openness level:
- enclosed houses,
- and unclosed ones.

Fig. 7: Plan of enclosed domed earthen house in Aleppo (Blas), composed of typical parts.



Under these two main typologies we can see other secondary ones:
- line-houses,
- dome-houses,
- plot-houses
- and single-room houses.[7]

The enclosed houses are nearly more spread in Idlib and Aleppo than Ar-Raqqah, because:
- most people of Idlib and Aleppo region are peasants, while there is a high percent of nomads in Ar-Raqqah and Al-Jazira region (and some eastern areas of Aleppo) which move and work as pastors of animals and do not spend long time in their unclosed houses.
- these typologies are related to the privacy concept adopted from proper habitants: because the habitants of unclosed houses (in some eastern villages of northern Syria), are not so interested of privacy as the habitants of enclosed houses (as in some villages in Aleppo and Idlib) because of religious values or social traditions. Sometimes the economic factor influences positively the number of enclosed houses, because rich people can feel more safe and protected from strangers or animals. Examples of enclosed houses are in Aleppo (Argel, Al-Safirah, Blas, Bza'a, Kelani, Khan Toman and Soran), Idlib (Al-Mastumeh, Ezmareen and Kafranbel) and Hama (Salamiyah).

According a second classification criterium based on shape of domed houses we may identify these architectural types:

1 Line-house: with a row of non-interrelated rooms, sometimes this line is extended in one direction, in two or three directions (Fig. 12).
2 Domed circular rooms: sometimes they are separated as in Idlib (Jobas) or connected as in Hama (Salamiyah) (Fig. 13).
3 Plot-houses: can be enclosed, or without fences built on regular plot defined by a large base *mastaba*; they are a characteristic urban feature of 3rd millennium Northern Mesopotamia.
4 Single-room-houses: are typical of the 3rd millennium sites of Tell Raqai and Tell Halwa. Examples of them can be found in many villages, especially in Idlib (Abu Kansa) and in Aleppo (Hamedea and Al-Wdehe) as in figure 8.Two or three rooms can be on the same row with one or more doors, examples of these are in Ar-Raqqah (Al-Baeda), In Aleppo (Tyara, Al-Safirah, Khan, Al-Asal, Azzan, Hamedeeh and Abed) and in Idlib (Abu Kansa and Murrat Al-Numan) (Fig. 9).

[7] Pfalzner 1996, p. 74.

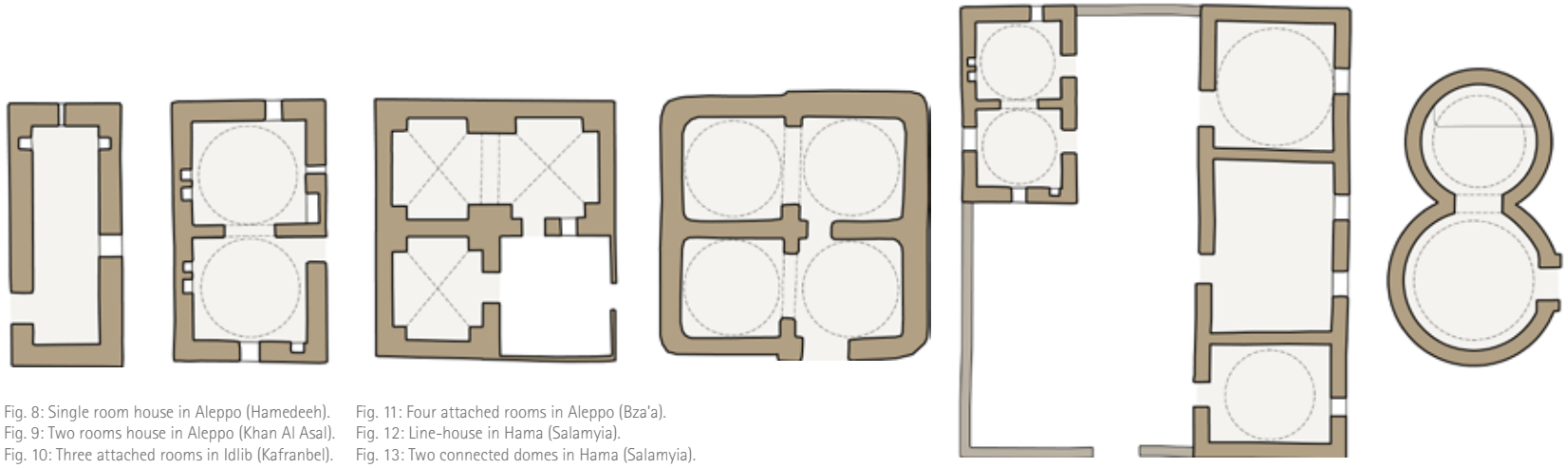


Fig. 8: Single room house in Aleppo (Hamedeeh).
Fig. 9: Two rooms house in Aleppo (Khan Al Asal).
Fig. 10: Three attached rooms in Idlib (Kafranbel).
Fig. 11: Four attached rooms in Aleppo (Bza'a).
Fig. 12: Line-house in Hama (Salamyia).
Fig. 13: Two connected domes in Hama (Salamyia).

5 Attached-rooms-houses: these houses are rare, sometimes we saw three domed rooms situated together as in Idlib (Kafranbel), Aleppo (Azzan) and in Ar-Raqqah (Laqta village) (Figs. 10-11).

According a third classification criterium based on shape of dome we may identify these architectural types:

1. Circular domed rooms: in this typology the dome starts from earth level (Fig. 14).
2. Quadrate domed rooms: they are named 'normal dome' and 'Sultan dome', *Qubba Sultanya*, which means 'the dome of the Sultan'; they are basically similar to circular domed rooms but the dome does not start from earth level, but it rest on walls starting from different heights (normal dome: 10-90 cm; sultanya dome: 1-2.5 meters). The Sultan domes usually have been built by rich people, as their construction (as we will see in the next paragraph) is more complicated relating to the first type (Fig. 15).

Construction technique of earthen domes.

Most of the earthen domes in North of Syria are built with three main earthen building techniques: earthen bricks (adobe), cob and mud-stone technique. There are other mud building techniques used in northern Syria as torchis and pisè techniques.

If we look for the history of earthen architecture techniques in Syria, we may see that the local techniques were discovered many thousands of years ago:

- The most ancient evidence of the *torchis* technique is in the interior walls of the circular houses in Tell Mureybet[8] at the end of the 9th millennium BC,

[8] The site of Mureybet, along the middle Euphrates River, was occupied from the 12th to the 8th millennium BC. It can be considered one of the earliest known agriculture-based settlements, the domestication of plants was traced in successive strata, making of Mureybet one of the reference sites for the progress of the Neolithic in the Ancient Near East. In 1971, Jacques Cauvin began the excavation at Mureybet, and discovered that the people of Mureybet at the earliest levels lived in round houses made of limestone bricks, with a clay mortar. In later strata, houses were rectangular.

Fig. 14: Simple domes in Idlib (Giobas).

Fig. 15: Sultan domes in South Aleppo.

Fig. 16a: Earthen brick technique (adobe) in Hama region (Salamiyah).
Fig. 16b: Earthen brick technique (adobe) in Hama region (Salamiyah).

Fig. 17a: Cob technique in Idlib (Giobas).
Fig. 17b: Deatil of cob technique in Idlib (Giobas).

- The oldest pisè technique evidence is almost known in the roofs of Tell Mureybet (8000 BC) and in Tell Ashaekh Hasan (7000 BC).[9]
- The oldest adobe technique evidence has been found nearly in, Tell Mureybet, Abu Huraira site (7000 BC), then in Tell Ashaekh Hasan site and Tell Aswad (6500 BC); this technique was used also in Mari site, Hammam Turkman, Tell Ar-ramah, Tell Brak and Tell Khazna (third millennium BC). In the second millennium BC Tell Al-Bae'a, Tell Ashaeekh Hamad and Leilan site have walls of adobe.
- The oldest cob technique evidence is known nearly in Tell Halaf (5000 BC) and Arbagiyah site (5000-4000 BC).

The today all the earthen architecture techniques are present in Syria: earthen bricks masonry or 'adobe' *(Attub* or *Al-Leben)*, cob *(Teen or Dewar)*, mud-stone *(Teen-Hajar)* (Figs. 16-18), 'pisè' *(Turab Madkuk)* and 'torchis' technique *(Khashab-Teen).* Earthen bricks, cob and mud-stone masonry techniques are approximately common in all the three regions: Ar-Raqqah (Al-Jazira and Euphrates region), Aleppo and Idlib (Aleppo Hadaba region), and Hama (Al-Hass Basin region).

Instead 'pisè' walls are less present because this construction technique needs more complex instruments and more work than cob technique. The 'torchis' technique is not present, except used in few small examples as animals stable, otherwise this technique is very common in the old city of Damascus**.** The main reason of the scarcity may be connected with the poor availability of raw materials employed by the proper technique, because the regions of Al-Jazira and Aleppo Hadaba are poor of wood and trunks, the main material of 'torchis' technique.

[9] Cauvin 1984, p. 53.

The mud-stone technique is diffused mainly in Idlib and in the western parts of Aleppo Hadaba region. This technique is very similar to cob technique except that the mud mixture of walls contains small unshaped stones and gravels, while the walls built with cob contain only mud with gravels and generally have not small stones in them. the diffusion of this technique in the up cited zones could be caused by the following factors:
- Idlib and the western parts of Aleppo Hadaba are more rainy than the other regions (East of Aleppo or Ar-Raqqah), because mud-stone walls resist rain and water more than cob walls.
- The clay in Idlib and western parts of Aleppo Hadaba is red and more rich of the 'montmorillonite' mineral than other regions; this mineral (as it is known) is responsible of water absorption and then of following shrinkage after the evaporation, for this reason it is impossible to build walls made completely of red mud mixture without supporting materials as small stones (the difference between cob and mud-stones).
- In some zones of Idlib area the cob technique is named *Dewar*, the

Fig. 18: Mud-stone technique in Aleppo (Saint Simon).

walls are constructed by an orange earth named *Gedare* which means 'valid earth to build a *Gedar* (a wall)'. The name of this technique *Dewar* is derived from the word *Dawr* (course), because the technique consists of building one *dawr* or two ones (courses of mud) in one day, one at the morning, second at the evening (Fig. 19).

Earthen domes shape and structure in northern syria.

We may identify two principal typologies of earthen domes: *normal dome* and *Sultan dome* 'Qubba Sultanya', this classification depending on the height from which starts the bottom circular base of the dome and on relation between the proper dome and the squared basement wall. We may observe the difference of mud dome shapes in Ar-Raqqah, Aleppo, Idlib and Hama and the method of dome construction in these regions according to diverse techniques. In ancient architecture of Syria the initial shapes of earthen houses roofs were flat for thousands of years, then the domed roofing started nearly in Tell Halaf (5000 millennium BC) and continued till nowadays and have been in use for centuries in traditional Syrian rural architecture.

It is well known in Syria that domes are better than flat roofs because their ogival shapes is cheaper, resist rain leakage, having less surface exposed to sun in the summer reduce solar radiation, achieving generally good climatic conditions in the interior space of the domed rooms.

Generally the thickness of the Syrian earthen domes at the bottom depends on singular adobe brick dimension, between 35-50 cm, it is more slim at the top, between 15-20 cm (Fig. 20).

Dome shapes

Although there are many differences of dome shapes in different areas the common character is that all of them, built with adobe technique, are corbelled domes, because their courses are set horizontally or better slightly tilted inwards, each course is laid out according to a spiral and cantilevered over the one before.

Main forms of earthen corbelled domes in Syria are parabolic, catenary, conic or multi-conic and truncated (Figs. 21-22-23).

The comparison between domes shapes gave us the following results:

- The *normal* simple domes in all regions (which start directly from earth level) are higher than sultanya domes, this means that the ratio 'height/

Fig. 19: Dewar technique or cob, is composed of earthen rows of mud in Hama region.
Fig. 20: Thickness of dome base is variable from place to another in South Aleppo.

Fig. 21: Triangular Domes in Ar-Raqqah city.

Fig. 22: Parabolic Domes in South Aleppo.

radius' is higher in normal domes, for that they seemed to be more slim (Figs. 24-26).

- The *Sultan domes* in Ar-Raqqah are wider at the bottom than ones at Idlib and Aleppo (the ratio 'height/radius' is lower).
- Only in rare cases earthen *sultanya domes* built on stone can be found (Fig. 27).
- The ratio between dome height and supporting walls height in *Sultan domes* is variable from 1/2 to 2 (Fig. 28).
- basically, while the exterior shape of the dome tends to be parabolic, the interior shape tends more to be conic or better composed of many truncated cons with three or four divers inclinations (Figs. 29-30).

Dome Construction methods

About construction method we may distinguish two principal techniques depending on the type of dome: *normal dome* (circular or square basis) and *Sultan dome* (supported on walls).

- The first type which start at ground level or above on a foundation wall, is the simple and the same in adobe or cob technique *Dewar*. We may distinguish two sub-types: circular basis or square basis
- the *circular normal dome* is the basic dome type, there are not complicated details, nor specific structural elements because the builder begins to form the dome shape from the ground level with a circular plan and do not need transition from one shape to another.
- the *square normal dome* is an evolution of the basic dome type, there are not complicated details, nor specific structural elements although the builder begins to form the dome shape from the ground level with a square plan and start to lay the bricks smoothing the corners in order to get transition from square shape to circular shape with 8-15 layers.
- The second type is the *Sultan dome* which is built on high or low square perimeter walls made of adobe, getting the transition from square to circle with the perimeter wall. We may distinguish two sub-types: dome supporting on perimeter wall with an external and an internal course or dome supporting on whole perimeter wall with an internal side shaped to get transition to circle.
- The dome supporting on an internal course are structurally close to the square normal dome, the exterior adobe or stone course stops nearly when the interior wall reach a circular shape or a little higher above it.
- The dome supporting on whole perimeter wall with a partial integration of pendentives.

The transition from square to circle

The building culture developed through thousands of years in Syria many ways to achieve the transition from square shape to circular one for realizing or supporting earthen corbelled domes:

Fig. 23: Triangular Domes in Euphrates region.
Fig. 24: Sultan domes in Hama region.

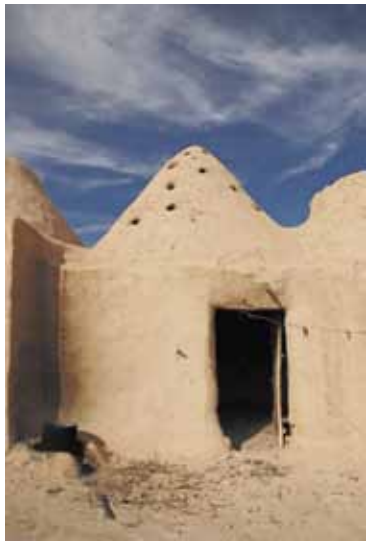



Fig. 25: Truncated Domes in Hama (Salamiyah).


Fig. 26: Simple domes are higher than Sultan ones in Hama region (Cheik Hilal).


Fig. 27: Domed stone rooms in Ar-Raqqah.


Fig. 28: Height ratio 'dome/room wall' in Aleppo (Habbuba).


Fig. 29: Exterior shape of a Domes in Hama region (Cheikh Hilal).

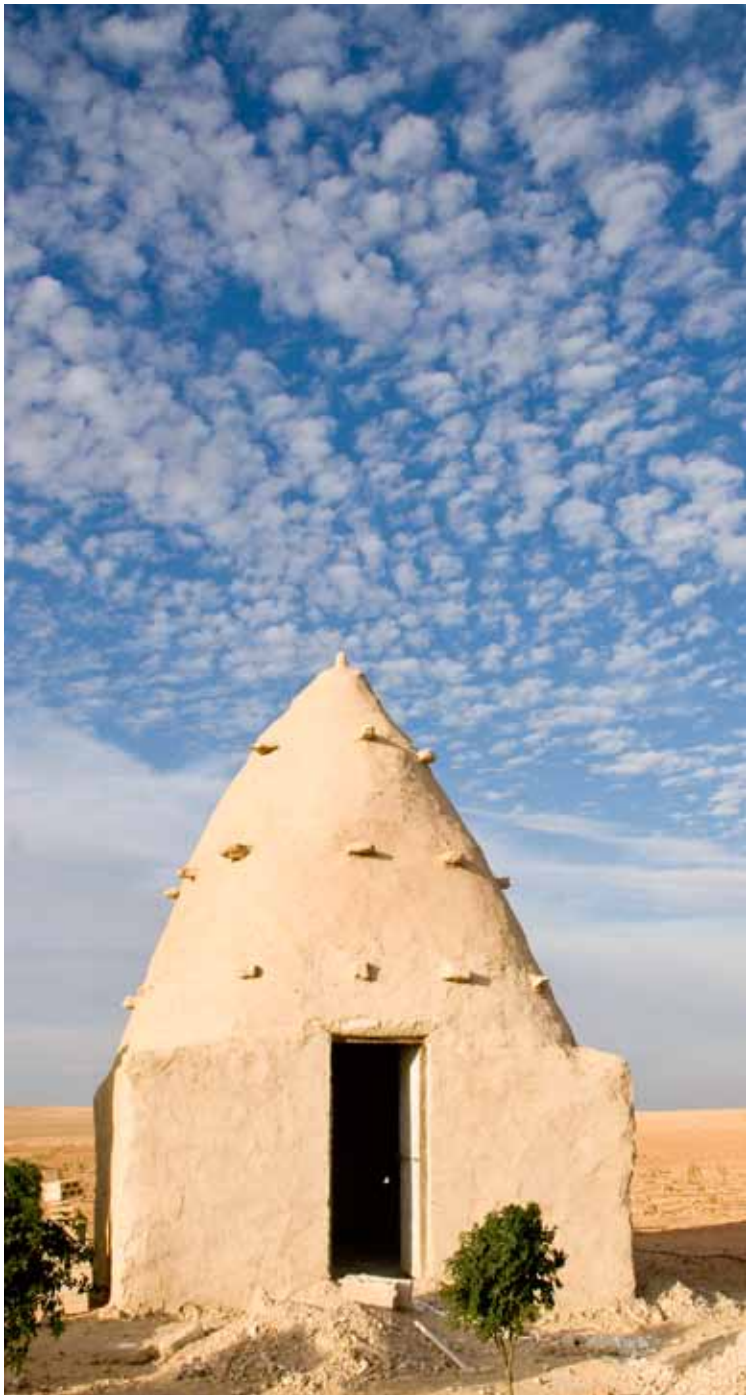


Fig. 30: A dome built in 2008 in Hama region (Cheikh Hilal).

- Domes on 'false' pendentives: this is the most diffused way: the transition to circular start with a corbel (a stone, a piece of wood or an earthen brick) in the angle on which the internal side of the wall is progressively, layer by layer in a corbelled way, shaped and adapted to a circular internal perimeter on which the corbelled dome will rests (Fig. 31).
- Domes on pendentives: in this case the dome rests on lower parts which have regular pendentives[10], at the corners of the square walls (Fig. 32).
- Buttresses: there are buttresses integrated with the walls, they form a first circular course of the dome, then the dome is so designed and lifted row after row of bricks adjusted by the expert mason *muallem* according to radius and inclination (Fig. 32).
- Squinch dome: whose lower circle is inscribed on the square and the interconnecting surfaces, called squinches[11], are composed of a series of arches of increasing radius or truncated dome resting on the inscribed diagonal square with the surfaces thus left being the squinches.[12]

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[10] A pendentive is a constructive device permitting the placing of a circular dome over a square room or an elliptical dome over a rectangular room. The pendentives, which are triangular segments of a sphere, taper to points at the bottom and spread at the top to establish the continuous circular or elliptical base needed for the dome. In masonry the pendentives thus receive the weight of the dome, concentrating it at the four corners where it can be received by the piers beneath.
Prior to the pendentive's development, the device of corbelling or the use of the squinch in the corners of a room had been employed. http://en.wikipedia.org/wiki/Pendentive.

[11] A squinch in architecture is a piece of construction used for filling in the upper angles of a square room so as to form a proper base to receive an octagonal or spherical dome. It was the primitive solution of this problem, the perfected one being eventually provided by the pendentive. Squinches may be formed by masonry built out from the angle in corbelled courses, by filling the corner with a vise placed diagonally, or by building an arch or a number of corbelled arches diagonally across the corner. http://en.wikipedia.org/wiki/Squinch.

[12] Minke 2006, p. 118.

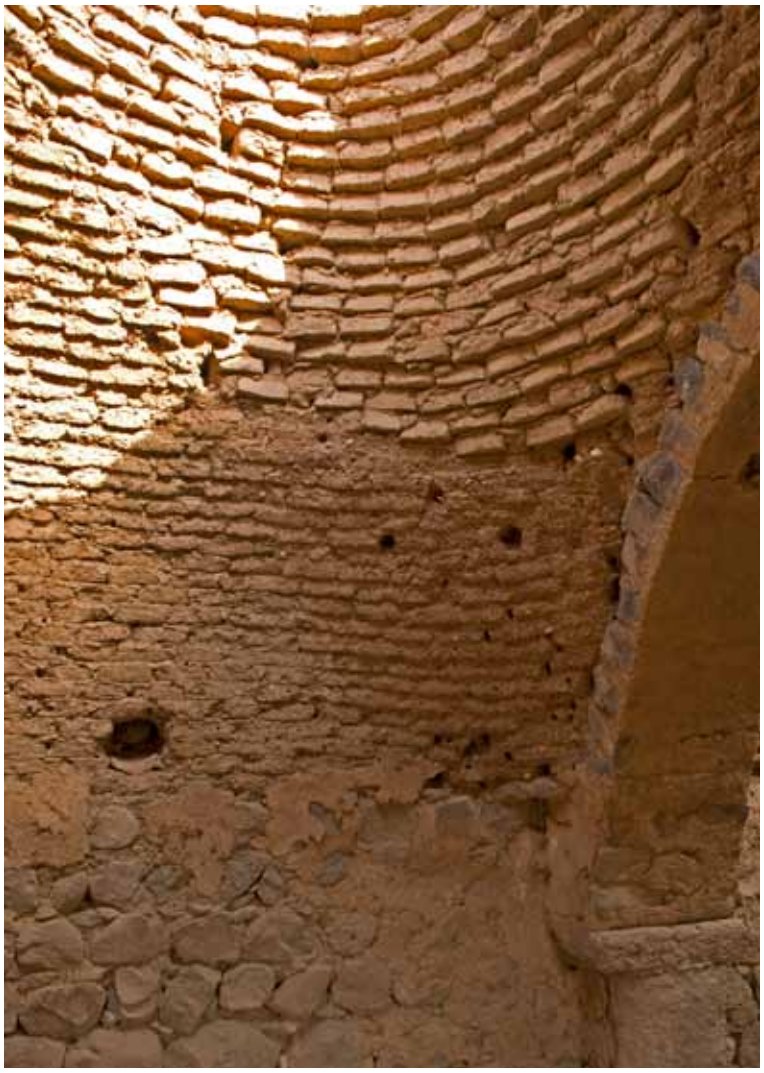

Fig. 31: A complex relation between basement, 'false' pendentive and dome masonries.

Fig. 32: Domes on pendentives in Idlib (Giobas).

Fig. 33: Domes based on buttresse in Ar-Raqqah city.

Fig. 34: Domes based on a squinch in Fourqlass